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Using BNC as Bioplasmonic Sensors

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Independent Study Report

Goal

The goal of my independent study was to focus on developing a biosensor that had a hot-spot localized surface based on BNC (bacterial nanocellulose). The template protein would be imprinted in Au nanorods and then followed with the polymerization of APTMS and TMPS, which will then allow the biosensor to have high selectivity and also be reusable. Initially when I started, this technique had already been developed and used on glass substrates, but not on a paper based substrate. The advantage of using a paper substrate, however, is that it is comparably cheap, portable, and easy for detection. We chose BNC paper because it is a novel but promising biomaterial that has a smoother surface and better mechanical properties than normal paper. The procedure that we wanted to perfect would allow template proteins to be imprinted on the surface of gold nanorods, which were absorbed by the BNC. The imprinted proteins could then be removed and leave an artificial receptor on the surface of the gold nanorods, which would enable template rebinding.

Progress/Results

Over the course of the semester, we were able to obtain a procedure in which a template protein (hemoglobin) could be imprinted on to the BNC surface. We were then able to remove the protein and test to see if rebinding would happen. For the imprinting process, the BNC was first immersed in AuNR solution, and then immersed in 100mM $NaBH_4$ to increase sensitivity. The imprinting process then

had BNC immersed with p-ATP and glutaraldehyde (GA) to serves as crosslinkers. In the next step, the template protein Hb (hemoglobin) was immobilized on the nanorods by exposing the BNC substrate to 0.05mg Hb solution at 4°C. Then, the substrate was immersed in a mixed solution of TMPS and APTMS. The proteins were released by being put in a solution of 2% SDS and oxalic acid. The LSPR shift was measured after every step to determine how much the shift was each time. After the protein removal, the protein immobilization step was repeated at a lower concentration to determine if protein rebinding would happen. Our results proved that our procedure did allow us to have protein rebinding on our BNC surface with gold nanorods, and thus we were successful in developing a procedure for BNC-based plasmonic bionsensors.

Future direction

Our next course of interest is in enabling the BNC substrate to detect multiple proteins. The multiplexing technique would allow multiple proteins to be distinguished at the same time, which is important for future applications. Diseases such as kidney cancer have multiple proteins as serve as biomarkers, and being able to detect all will help determine the diagnosis in the urine test. We plan to find a technique to enable the BNc surface for multiplexing for future directions.